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Morphological Phenotyping of Zebrafish Mutants Using Synchrotron-based Micron-scale Computed Tomography

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The study of vertebrate organisms with single-gene defects is important for probing the function of genes and for translating such work to analogous defects in humans. Because these defects often operate at the level of single cells, their documentation requires information from the length scale of single cells to the length scale of the entire organism. Optical modalities are ideal for probing small organisms, tissues sections, or even single cells in two and three dimensions; however, optical methods are severely limited by tissues thicker than ~200 microns and rarely shed light on the continuum of length scales between the single cell and the whole organism within a single data set. As an alternative to optical methods, we have employed the use Argonne National Laboratory's Advanced Photon Source to conduct micron-scale computed tomography of the small vertebrate model system, the zebrafish. Reported are the results of scanning larval and juvenile zebrafish, demonstrating the continuum of length scales from the whole organism down to single cells within a single scan. As part of the zebrafish phenome project, it will be possible to quantitatively document morphological changes within the zebrafish caused by mutation in each protein-encoding gene (~20,000 genes).